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Evaluation of Dietary Inclusion of Specialty Protein Ingredients on Nursery Pig Performance

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Abstract

A total of 1,215 pigs (PIC 337 × 1050; initially 11.0 lb body weight) were used in a 42-d growth trial to evaluate a new specialty protein blend prototype (Protein Blend, International Ingredient Corp., St. Louis, MO) on nursery growth performance. Pigs were randomly assigned to pens (27 pigs per pen) and pens were allotted by weight to 1 of 5 dietary treatments in a randomized complete block design with 9 pens per treatment. Treatments were arranged in a 2 × 2 + 1 negative control factorial arrangement with main effects of protein source (HP300, Hamlet Protein, Findlay, OH; and Protein Blend) and 2 dietary levels (5 and 10%). Treatment diets were fed in two phases for 21 days (phase 1 = d 0 to 7; phase 2 = d 7 to 21). All pigs were then fed a common phase 3 diet from d 21 to 42. For the treatment period (d 0 to 21), there was a protein source effect with pigs fed diets containing HP300 having greater ($P < 0.05$) average daily gain (ADG) and average daily feed intake (ADFI) and improved ($P < 0.05$) feed efficiency (F/G) compared to pigs fed diets containing the Protein Blend. Also, ADG and ADFI decreased (linear, $P < 0.05$) for pigs fed increasing levels of Protein Blend. Furthermore, pigs fed increasing levels of the Protein Blend had worse (quadratic, $P = 0.050$) F/G. Overall (d 0 to 42), there was a protein source effect in which pigs fed HP300 had improved ($P < 0.05$) ADG and tendency ($P < 0.086$) for improved F/G compared to pigs fed diets with the Protein Blend. Subsequent lab analysis revealed that Protein Blend was lower in crude protein and amino acids than formulated values. In summary, feeding the Protein Blend at increasing levels decreased performance compared to feeding diets containing HP300.

Keywords

growth, nursery pig, protein source

Cover Page Footnote

Appreciation is expressed to International Ingredient Corp., St. Louis, MO for partial financial support of this project. Appreciation is expressed to New Horizon Farms, Pipestone, MN, for their technical support and expertise in conducting the experiment.

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K-STATE Research and Extension

Swine Day 2020

KANSAS STATE UNIVERSITY SWINE INDUSTRY DAY 2020

Evaluation of Dietary Inclusion of Specialty Protein Ingredients on Nursery Pig Performance[1,2]

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Summary

A total of 1,215 pigs (PIC 337 × 1050; initially 11.0 lb body weight) were used in a 42-d growth trial to evaluate a new specialty protein blend prototype (Protein Blend, International Ingredient Corp., St. Louis, MO) on nursery growth performance. Pigs were randomly assigned to pens (27 pigs per pen) and pens were allotted by weight to 1 of 5 dietary treatments in a randomized complete block design with 9 pens per treatment. Treatments were arranged in a 2 × 2 + 1 negative control factorial arrangement with main effects of protein source (HP300, Hamlet Protein, Findlay, OH; and Protein Blend) and 2 dietary levels (5 and 10%). Treatment diets were fed in two phases for 21 days (phase 1 = d 0 to 7; phase 2 = d 7 to 21). All pigs were then fed a common phase 3 diet from d 21 to 42. For the treatment period (d 0 to 21), there was a protein source effect with pigs fed diets containing HP300 having greater ($P < 0.05$) average daily gain (ADG) and average daily feed intake (ADFI) and improved ($P < 0.05$) feed efficiency (F/G) compared to pigs fed diets containing the Protein Blend. Also, ADG and ADFI decreased (linear, $P < 0.05$) for pigs fed increasing levels of Protein Blend. Furthermore, pigs fed increasing levels of the Protein Blend had worse (quadratic, $P = 0.050$) F/G. Overall (d 0 to 42), there was a protein source effect in which pigs fed HP300 had improved ($P < 0.05$) ADG and tendency ($P < 0.086$) for improved F/G compared to pigs fed diets with the Protein Blend. Subsequent lab analysis revealed that Protein Blend was lower in crude protein and amino acids than formulated values. In summary, feeding the Protein Blend at increasing levels decreased performance compared to feeding diets containing HP300.

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[2] Appreciation is expressed to New Horizon Farms, Pipestone, MN, for their technical support and expertise in conducting the experiment.

[3] Department of Diagnostic Medicine/Pathology, College of Veterinary Medicine, Kansas State University.

[4] International Ingredient Corp., St. Louis, MO.

Introduction

Specialty protein sources are included in early nursery diets to provide highly digestible amino acids for the pig and to potentially stimulate feed intake. Further processed soybean products, such as enzymatically treated or fermented products, are examples of the type of product that is often included in nursery diets to lower the level of conventional soybean meal.

Due to the continual need of high quality protein sources in starter diets, new products are continually being developed and evaluated for use in nursery diets immediately post-weaning. International Ingredient has developed a new specialty protein blend prototype (Protein Blend; International Ingredient Corp., St. Louis, MO), which is a blend of soy protein isolate, fermented biomass, and chocolate powder that has the potential to be used in nursery diets to help promote growth performance. Therefore, the objective of this study was to evaluate a newly developed specialty protein source, Protein Blend, on nursery pig growth performance.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The experiment was conducted at New Horizon Farms Nursery Research (Pipestone, MN). Each pen (12 × 8 ft) had plastic slatted floors and was equipped with a six-hole stainless steel dry feeder and a pan waterer to provide *ad libitum* access of feed and water.

A total of 1,215 pigs (PIC 337 × 1050; initially 11.0 lb BW) were placed in 45 pens with 27 mixed gender pigs each and used in a 42-d trial. Pigs were weaned at approximately 19 d of age and placed in pens based on initial body weight (BW). Pens of pigs were blocked by BW and allotted to 1 of 5 dietary treatments in a randomized complete block design. Treatments were arranged in a 2 × 2 + 1 negative control factorial design with main effects of protein source (HP300 and Protein Blend) and two dietary levels (5 and 10%). Treatment diets were fed in two phases for 21 days (phase 1 = d 0 to 7; phase 2 = d 7 to 21). Diets were formulated to similar levels of soybean meal at 5 and 10% for each protein source by adjusting L-lysine HCl. All pigs were then fed a common phase 3 diet from d 21 to 42. Amino acids and other nutrients were formulated to meet the NRC (2012) requirements for each weight range (phase) of the study. Nutrient values for HP300 and Protein Blend were provided by the manufacturer and used in diet formulation. Phase 1 was pelleted (Hubbard Feeds, Worthington, MN) and phases 2 and 3 were fed in meal form (New Horizon Farms feed mill, Pipestone, MN). Pens of pigs were weighed, and feed disappearance was measured weekly to determine ADG, ADFI, and F/G.

Samples of HP300 and Protein Blend were obtained from each feed manufacturing location and submitted to Agricultural Experimental Station Chemical Laboratories (University of Missouri-Columbia, Columbia, MO) for analysis of crude protein, amino acid concentration, dry matter, sodium and chloride.

Data were analyzed as a 2 × 2 + 1 factorial design with main effects of protein source and dietary levels. Block was included as a random effect and treatment was a fixed

effect. Pen was considered the experimental unit. Data were analyzed using the lmer function from the lme4 package in R (version 3.5.2 (2018-12-20)). Statistical models were fitted using RStudio7 (Version 3.5.2, R Core Team, Vienna, Austria). Predetermined orthogonal contrasts were used to evaluate linear or quadratic effects within source (0, 5, and 10%). All results were considered significant at $P \leq 0.05$, and marginally significant at $0.05 \leq P \leq 0.10$.

Results and Discussion

Chemical analysis of HP300 and Protein Blend is presented in Table 4. For HP300, analyzed values were consistent with formulated values. However, the Protein Blend product had slightly lower crude protein and amino acids for product used in phase 1 and was markedly lower for the product used in phase 2. For phase 2, there was ~30-40% difference between analyzed and formulated values, with subsequent records suggesting this discrepancy was related to a manufacturing deviation.

From d 0 to 7, there was no difference between sources of specialty protein. As HP300 or Protein Blend increased in the diet, ADG decreased (linear, $P < 0.05$). Also, as Protein Blend increased in the diet, there was a linear increase ($P = 0.008$) in F/G.

From d 7 to 21, pigs fed diets containing HP300 had improved ($P < 0.050$) ADG, ADFI, and F/G compared to the pigs fed diets containing the Protein Blend. For pigs fed increasing amounts of Protein Blend, there was a decrease in ADG (quadratic, $P = 0.043$) and ADFI (linear, $P = 0.005$) with F/G being similar for the control diet and 10% Protein Blend and the 5% Protein Blend having the poorest F/G (quadratic, $P = 0.008$). There was a linear decrease ($P = 0.035$) in d 21 BW as Protein Blend increased in the diet, whereas there was no evidence for differences in ADG, ADFI, or d 21 BW when HP300 increased in the diet.

From d 0 to 21 (treatment period), there was a protein source effect ($P < 0.050$) for ADG, ADFI, and F/G with pigs being fed the Protein Blend having reduced performance compared to pigs fed diets containing HP300. Average daily gain and ADFI decreased (linear, $P < 0.05$) for pigs fed increasing levels of the Protein Blend. Furthermore, pigs fed increasing levels of the Protein Blend had worse (quadratic, $P = 0.050$) F/G. There were no effects on performance for pigs fed increasing levels of HP300 from d 0 to 21. From d 21 to 42, when a common diet was fed to all pigs, there was no evidence for differences for pigs previously fed different specialty protein sources in the diet.

Overall (d 0 to 42), there was a protein source effect in which pigs fed the Protein Blend had lower ($P < 0.05$) ADG and a tendency ($P < 0.086$) for reduced F/G compared to pigs fed diets with HP300.

In summary, feeding the Protein Blend at increasing levels led to decreased performance. Also, pigs fed the Protein Blend had poorer performance compared to pig fed diets containing HP300. While reason(s) for this finding is not fully known, the lower analyzed amino acid values for the Protein Blend was a likely contributor.

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Table 1. Composition of experimental diets, phase 1 (as-fed basis)[1]

	Negative	HP300[2]		Protein blend[3]	
Ingredient, %	control	5%	10%	5%	10%
Corn	35.05	35.95	36.90	36.05	37.05
Soybean meal	27.20	21.30	15.40	21.30	15.40
Spray-dried whey	12.50	12.50	12.50	12.50	12.50
Whey permeate	11.25	11.25	11.25	11.25	11.25
DDGS[4]	5.00	5.00	5.00	5.00	5.00
Corn oil	3.00	3.00	3.00	3.00	3.00
Protein Blend	---	---	---	5.00	10.00
HP300	---	5.00	10.00	---	---
Bovine blood plasma	2.50	2.50	2.50	2.50	2.50
Calcium carbonate	0.95	0.95	0.975	0.95	0.95
Monocalcium phosphate	0.75	0.75	0.75	0.78	0.80
Sodium chloride	0.20	0.20	0.20	0.20	0.20
L-Lysine-HCl	0.40	0.40	0.40	0.41	0.42
DL-Methionine	0.21	0.21	0.21	0.21	0.21
L-Threonine	0.20	0.21	0.21	0.09	---
L-Tryptophan	0.01	0.01	0.01	0.01	0.02
L-Valine	0.10	0.09	0.09	0.07	0.04
Zinc oxide	0.42	0.42	0.42	0.42	0.42
Trace mineral premix	0.13	0.13	0.13	0.13	0.13
Selenium premix 0.06%	0.05	0.05	0.05	0.05	0.05
Quantum Blue 5G[5]	0.02	0.02	0.02	0.02	0.02
Vitamin premix	0.05	0.05	0.05	0.05	0.05
Total	100.00	100.00	100.00	100.00	100.00

continued

Table 1. Composition of experimental diets, phase 1 (as-fed basis)[1]

Ingredient, %	Negative control	HP300[2]		Protein blend[3]	
		5%	10%	5%	10%
Calculated analysis					
SID amino acids, %					
Lysine	1.40	1.40	1.40	1.40	1.40
Isoleucine:lysine	56	57	58	57	59
Leucine:lysine	115	116	117	117	119
Methionine:lysine	35	35	35	36	36
Methionine and cysteine:lysine	58	58	58	58	58
Threonine:lysine	66	66	66	66	67
Tryptophan:lysine	18.8	19.0	18.8	18.8	18.8
Valine:lysine	70	70	70	70	70
Histidine:lysine	35	35	35	34	34
Net energy, kcal/lb	1,185	1,192	1,199	1,206	1,226
Crude protein, %	21.7	21.8	21.8	21.5	21.3
Calcium	0.70	0.70	0.70	0.70	0.70
STTD P, %	0.55	0.55	0.55	0.55	0.55

[1]Phase 1 diets were fed for 7 d in pellet form.
[2]Hamlet protein, Findlay, OH.
[3]International Ingredient Corp., St. Louis, MO.
[4]Dried distillers grains with solubles.
[5]Quantum Blue 5G (AB Vista, Marlborough, UK) provided 510 phytase units (FTU)/lb of diet, for an estimated available phosphorus release of 0.14%.

Table 2. Composition of experimental diets, phase 2 (as-fed basis)[1]

Ingredient, %	Negative control	HP300[2] 5%	HP300[2] 10%	Protein blend[3] 5%	Protein blend[3] 10%
Corn	44.00	44.85	45.80	45.00	45.95
Soybean meal	32.20	26.30	20.35	26.25	20.35
DDGS[4]	10.00	10.00	10.00	10.00	10.00
Whey permeate	9.00	9.00	9.00	9.00	8.00
Protein Blend	---	---	---	5.00	10.00
HP300	---	5.00	10.00	---	---
Beef tallow	1.00	1.00	1.00	1.00	1.00
Calcium carbonate	1.05	1.08	1.08	1.05	1.08
Monocalcium phosphate	0.85	0.85	0.85	0.88	0.90
Sodium chloride	0.55	0.55	0.55	0.55	0.55
L-Lysine-HCl	0.45	0.45	0.45	0.46	0.47
DL-Methionine	0.18	0.18	0.18	0.18	0.18
L-Threonine	0.20	0.20	0.20	0.08	---
L-Tryptophan	0.01	0.02	0.02	0.02	0.02
L-Valine	0.08	0.07	0.05	0.04	0.02
Zinc oxide	0.27	0.27	0.27	0.27	0.27
Vitamin and trace mineral premix	0.15	0.15	0.15	0.15	0.15
Optiphos 2000[5]	0.05	0.05	0.05	0.05	0.05
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis					
SID amino acids, %					
Lysine	1.35	1.35	1.35	1.35	1.35
Isoleucine:lysine	60	60	61	61	62
Leucine:lysine	125	126	127	127	129
Methionine:lysine	36	36	36	36	37
Methionine and cysteine:lysine	58	58	58	58	58
Threonine:lysine	65	65	65	65	67
Tryptophan:lysine	18.6	18.8	18.6	18.6	18.5
Valine:lysine	70	70	70	70	70
Histidine:lysine	38	38	38	37	37
Net energy, kcal/lb	1,111	1,118	1,125	1,132	1,152
Crude protein, %	22.8	22.9	22.9	22.6	22.4
Calcium	0.70	0.70	0.70	0.70	0.70
STTD P, %	0.51	0.51	0.51	0.51	0.51

[1]Phase 2 diets were fed from d 7 to 21.
[2]Hamlet protein, Findlay, OH.
[3]International Ingredient Corp., St. Louis, MO.
[4]Dried distillers grains with solubles.
[5] Optiphos 2000, (Huvepharma Inc., Peachtree City, GA) provided 450 phytase units (FTU)/lb of diet, for an estimated available phosphorus release of 0.14%.

Table 3. Experimental diets, phase 3 (as-fed basis)[1]

Ingredients, %	Common diet
Corn	48.37
Soybean meal	27.32
DDGS[2]	20.00
Beef tallow	1.00
Calcium carbonate	1.25
Sodium chloride	0.55
Monocalcium phosphate	0.50
L-Lysine-HCl	0.50
DL-Methionine	0.10
L-Threonine	0.12
L-Tryptophan	0.02
L-Valine	0.05
Vitamin and trace mineral premix	0.15
Optiphos 2000[3]	0.05
Tri-basic copper chloride	0.02
Total	100.00
Calculated analysis	
SID amino acids, %	
Lysine	1.30
Isoleucine:lysine	61
Leucine:lysine	140
Methionine:lysine	33
Methionine and cysteine:lysine	57
Threonine:lysine	62
Tryptophan:lysine	18.3
Valine:lysine	72
Histidine:lysine	40
Net energy, kcal/lb	1,105
Crude protein, %	23.3
Calcium	0.68
STTD P, %	0.45

[1]Phase 3 diets were fed from d 21 to 42 during the common period.
[2]Dried distillers grains with solubles.
[3]Optiphos 2000, (Huvepharma Inc., Peachtree City, GA) provided 450 phytase units (FTU)/lb of diet, for an estimated release of 0.14%.

Table 4. Chemical analysis of specialty protein ingredients (as fed basis)[1]

	HP300[2]			Protein Blend[3]		
Item, %	Formulated	Phase 1	Phase 2	Formulated	Phase 1	Phase 2
Dry matter	92.0	93.47	94.93		94.75	94.39
Crude protein	56.0	55.06	55.42	52.0	48.77	36.80
Crude fat	2.5	1.14	2.12	4.5	4.50	3.25
Sodium	0.04	0.003	0.002	1.08	0.546	0.397
Chloride	0.06	<0.1	<0.1		0.4	0.3
Total amino acids						
Lysine	3.43	3.33	3.26	3.22	2.83	2.08
Methionine	0.76	0.76	0.75	0.98	0.86	0.68
Threonine	2.14	2.13	2.07	4.48	4.37	2.84
Tryptophan	0.77	0.75	0.76	0.66	0.53	0.48
Valine	2.70	2.86	2.78	3.16	2.73	1.93
Isoleucine	2.67	2.69	2.65	2.80	2.33	1.66
Leucine	4.27	4.27	4.20	4.55	4.00	2.82
Histidine	1.42	1.44	1.41	1.24	1.05	0.77
Arginine	3.86	3.88	3.85	3.51	2.95	2.07
Cysteine	0.74	0.79	0.78	0.54	0.50	0.37
Phenylalanine	2.85	2.88	2.83	2.68	2.24	1.63
Tyrosine	1.94	2.06	2.04	1.96	1.70	1.17

[1]Values represent composite sample for each feed ingredient taken from 2 different locations/lots. Phase 1 samples were from Hubbard Feed Mill, Worthington, MN. Phase 2 samples were from New Horizon Feed Mill, Pipestone, MN.
[2]Hamlet Protein, Findlay, OH.
[3]International Ingredient Corp., St. Louis, MO.

Table 5. Interactive effect of HP300 and Protein Blend on nursery pig performance[1]

							Probability, *P* =				
		HP300[2]		Protein Blend[3]				HP300		Protein Blend	
	Control	5%	10%	5%	10%	SEM	Source	Linear	Quadratic	Linear	Quadratic
BW, lb											
d 0	11.1	11.0	11.0	11.0	11.0	0.160	0.974	0.609	0.609	0.546	0.767
d 7	12.7	12.4	12.4	12.5	12.3	0.198	0.914	0.113	0.274	0.033	0.800
d 21	21.3	21.6	21.5	20.4	20.4	0.354	0.001	0.767	0.536	0.035	0.204
d 42	44.4	44.4	43.8	43.2	43.2	0.738	0.130	0.475	0.631	0.154	0.424
d 0 to 7[4]											
ADG, lb	0.24	0.20	0.20	0.20	0.17	0.014	0.505	0.049	0.227	0.001	0.864
ADFI, lb	0.45	0.45	0.43	0.46	0.44	0.010	0.297	0.114	0.850	0.415	0.596
F/G	1.94	2.54	2.29	2.28	2.86	0.232	0.510	0.287	0.142	0.008	0.695
d 7 to 21											
ADG, lb	0.61	0.63	0.63	0.55	0.56	0.016	0.001	0.208	0.603	0.032	0.043
ADFI, lb	0.91	0.91	0.89	0.87	0.83	0.020	0.007	0.497	0.593	0.005	0.873
F/G	1.50	1.45	1.41	1.59	1.48	0.035	0.001	0.028	0.963	0.649	0.008
d 0 to 21 (treatment period)											
ADG, lb	0.48	0.48	0.48	0.43	0.43	0.013	0.001	0.876	0.654	0.003	0.123
ADFI, lb	0.76	0.75	0.73	0.73	0.70	0.013	0.019	0.243	0.851	0.002	0.972
F/G	1.57	1.58	1.52	1.70	1.65	0.035	0.001	0.286	0.414	0.118	0.050
d 21 to 42 (common period)											
ADG, lb	1.08	1.08	1.04	1.07	1.08	0.023	0.970	0.465	0.754	0.889	0.516
ADFI, lb	1.54	1.57	1.53	1.52	1.57	0.036	0.910	0.663	0.350	0.549	0.303
F/G	1.42	1.45	1.43	1.43	1.45	0.027	0.922	0.739	0.386	0.307	0.622
d 0 to 42											
ADG, lb	0.78	0.77	0.77	0.74	0.75	0.016	0.050	0.703	0.893	0.108	0.213
ADFI, lb	1.14	1.15	1.13	1.11	1.13	0.022	0.277	0.469	0.486	0.439	0.320
F/G	1.47	1.49	1.46	1.50	1.51	0.021	0.086	0.742	0.249	0.112	0.509

[1]1,215 pigs (PIC 337 × 1050; initially 11.02 lb body weight) were placed in 45 pens with 27 mixed gender pigs each and used in a 42-d trial.
[2]Hamlet Protein, Findlay, OH.
[3]International Ingredient Corp., St. Louis, MO.
[4]Phase 1 diets were fed from d 0–7; Phase 2 diets were fed from d 7–21.